Appendix B

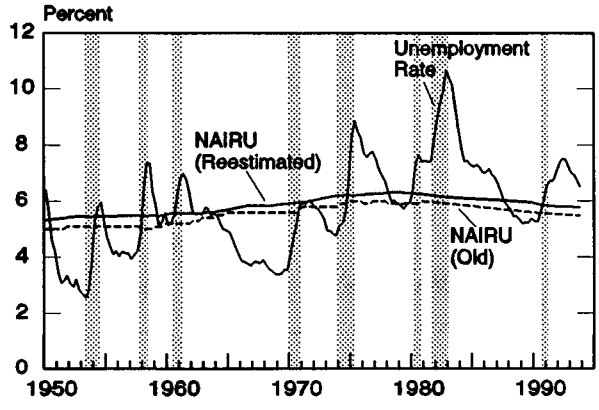
Reestimating the NAIRU

The Congressional Budget Office (CBO) has recently reestimated the nonaccelerating inflation rate of unemployment (NAIRU) and has concluded that it is about three-tenths of a percentage point higher than was previously thought (see Figure B-1). The NAIRU is a summary measure of capacity in the labor market that plays an important role in CBO's projections of inflation and growth of real gross domestic product (GDP).[1] Historically, the rate of inflation increases when the rate of unemployment falls below the NAIRU and decreases when the unemployment rate rises above the NAIRU. The upward revision implies, therefore, that inflationary pressures are likely to occur at a slightly higher rate of unemployment than they would under the old estimate. CBO's estimate of the NAIRU affects the projection for growth of real GDP because it is an important determinant (though not the sole determinant) of CBO's estimate of potential output.

CBO reestimated the NAIRU because of a growing consensus that the economy is approaching its productive capacity and could be in danger of overheating. The new estimate differs from the old for three reasons: first, it is calculated using a longer data sample; second, the data used for the calculation have been revised; and third, a new (and better) measure of inflation is used.

The upward revision to the NAIRU is not related to the revision to the unemployment portion of the Current Population Survey (CPS) made by the Bureau of Labor Statistics in January (see Box 1-1 in Chapter 1). For 1993 and earlier, CBO's estimated value of the NAIRU is based on the old method for the unemployment survey. Beginning in 1994, however, the NAIRU estimates should be adjusted upward by another one-quarter of one percentage point to account for the new survey methods. The estimate of the 1994 level of the NAIRU is 6 percent using the new survey, a rate that is comparable to the data on the unemployment rate now being released.

Figure B-1.
The Unemployment Rate, the Reestimated NAIRU, and the Old NAIRU



SOURCES: Congressional Budget Office; Department of Labor, Bureau of Labor Statistics.

NOTE: Data for the unemployment rate and the nonaccelerating inflation rate of unemployment (NAIRU) are on the old basis, as reported before the January 1994 revision of the Current Population Survey. Values of the NAIRU are estimated by CBO.

1. For a discussion of the NAIRU, see Congressional Budget Office, *The Economic and Budget Outlook: Fiscal Years 1995-1999* (January 1994), p. 18. See also W.W. Lang, "Is There a Natural Rate of Unemployment?" *Business Review*, Federal Reserve Bank of Philadelphia (March/April 1990), pp. 13-22; or S.E. Weiner, "The Natural Rate of Unemployment: Concepts and Issues," *Economic Review*, Federal Reserve Bank of Kansas City (January 1986), pp. 11-24.

Procedure for Estimating the NAIRU

Computing the NAIRU involves the statistical estimation of equations, known as Phillips curves, that describe the primary influences on the short-term process of wage and price adjustment in the economy.[2] Phillips curves capture an important statistical regularity: that higher rates of inflation have historically been associated with lower rates of unemployment. When total demand in the economy presses against the limits of what the economy can supply, companies frequently raise the prices of their goods and services. They also typically hire more workers to meet the larger demand, thereby lowering the rate of unemployment and bidding up wages. When demand falls below the economy's capacity, the opposite happens: companies cut prices to move their goods while they reduce their payrolls to lower costs, thus raising unemployment and slowing the growth of wages.

The Phillips curve, in its simplest form, posits an inverse relationship between the rate of inflation and the rate of unemployment. Past research, however, has found that the basic Phillips curve relationship broke down during the 1970s, when the United States experienced high inflation and high unemployment at the same time. To cope with periods like the 1970s, when fluctuations in total supply dominated the economy, the simple theory must be augmented to include variables that capture the effects of supply shocks (such as sharp increases in the price of energy) and the process by which markets form expectations of future inflation. A Phillips curve equation that allows for shifts in total demand and supply can successfully explain the movements of inflation and can be solved for the desired estimate of the NAIRU.

For its Phillips curve, CBO estimates a regression in which inflation--measured as the percentage change in the overall price level--is the dependent variable. The explanatory variables include lagged (that is, past) values of inflation (to represent expected inflation); lagged values of the unemployment rate of a reference group in the labor force (to model total demand); a variable measuring productivity growth; a variable to control for food and energy prices; and dummy variables to control for the imposition of wage and price controls during the early 1970s. CBO uses the unemployment rate of a reference group, married males, to measure the level of demand in the economy because the overall unemployment rate is affected by changes in the composition of the labor force. (For example, the overall unemployment rate could rise despite unchanged demand if there was an influx of youths, who traditionally have a high rate of unemployment, into the labor force.) The Phillips curve equation can be solved for the rate of unemployment that would keep the rate of inflation constant, which is the NAIRU for the reference group.

The NAIRUs for individual demographic groups in the labor force can be computed from the married-male NAIRU.[3] CBO estimates regressions that relate the unemployment rate for each demographic group to the unemployment rate for married males. The NAIRU for each demographic group is calculated by inserting the NAIRU for married males into each of these equations. The overall NAIRU is then computed as a weighted average of the NAIRUs of the demographic groups, with the groups' labor force shares used as the weights. Note that the NAIRU for married males and for each of the other demographic groups is constant during the sample; the overall NAIRU varies over time only because shares of the labor force change over time.

Issues in Estimating the NAIRU

The most important estimation issue is what measure of inflation to use. There are several choices: implicit deflators, fixed-weighted price indexes, and

2. For other estimates of the NAIRU, see R.G. Gordon, "Inflation, Flexible Exchange Rates, and the Natural Rate of Unemployment," in M.N. Baily, ed., *Workers, Jobs and Inflation* (Washington, D.C.: Brookings Institution, 1982); S.E. Weiner, "New Estimates of the Natural Rate of Unemployment," *Economic Review*, Federal Reserve Bank of Kansas City (Fourth Quarter 1993), pp. 53-69; and S.N. Braun, "Productivity and the NIIRU (and Other Phillips Curve Issues)," Working Paper 34 (Federal Reserve Board of Governors, June 1984).

3. CBO breaks the labor force down by sex, race (white/nonwhite), and age (16-19, 20-24, 25-34, 35-44, 45-54, 55-64, and 65 and over).

several alternative price indexes. Using an implicit deflator, such as the implicit GDP deflator, is inappropriate because it measures not only changes in prices but also changes in the mix of purchases. Thus, the series could show a decline in inflation not because the growth of prices slowed, but because consumers shifted their spending to goods with prices that had increased less since 1987.

A fixed-weighted index, such as the fixed-weighted GDP price index, is a purer measure of inflation because it computes the change in the prices of a fixed market basket of goods. It therefore avoids the main problem associated with implicit deflators. However, it also has shortcomings, two in particular.

First, the index is likely to provide a misleading picture of inflation for years that are far removed from the base year, because the pattern of spending is locked to that in the base year. The current base year, for example, is 1987; goods whose share of consumer and business expenditures has increased during the postwar period will be weighted too heavily in the index early in the sample, because the index assumes a mix of purchases from 1987. The opposite holds true for goods whose expenditure share has decreased through time--they will be underrepresented early in the sample.

Second, the entire history of the series changes when the base year changes, which happens when the Bureau of Economic Analysis (BEA) rebenchmarks the national income and product accounts (NIPAs). Since the rate of unemployment is not subject to such revision, the entire relationship between inflation and unemployment changes each time the NIPAs are rebenchmarked. The problem is particularly acute for early years in the sample, because they are farther away from the base year.

Perhaps the best measure of inflation to use is a price index whose weights change, but only infrequently during the data sample. Year-to-year changes in such an index would reflect only changes in prices (not changes in the spending mix), but the weights for any given year would never be too different from the actual pattern of spending for that year. By this criterion, the CPI-U (the consumer price index for all urban consumers) seems to be a good candidate.[4] However, the CPI's weights are somewhat out of date since they derive from surveys performed between 1982 and 1984. CBO therefore uses one of BEA's alternative price indexes for gross domestic product, the benchmark-years-weighted price index.[5] The advantage of this index is that its weights change infrequently during the postwar period, roughly every five years when BEA rebenchmarks the NIPAs. Values of the index in years since 1987 (the most recent base year) incorporate weights computed from expenditure shares in 1987 and in the last year of the sample, which is now 1993. Thus, although post-1987 values of the index are subject to revision until the next rebenchmarking, more distant history is not.

Besides the benchmark-years-weighted price index for GDP, CBO estimated NAIRUs using four other measures of inflation to gauge the sensitivity of the results. The other inflation measures are the benchmark-years-weighted price index for personal consumption expenditures (PCE), the CPI-U, the fixed-weighted PCE price index, and the fixed-weighted price index for PCE less food and energy. Fortunately, the estimates of the NAIRU computed using these different measures of inflation all clustered in a small range.

The foregoing discussion ignores the CPS revision introduced in January 1994 because all of CBO's NAIRU estimates use the old definition of the unemployment rate. The Bureau of Labor Statistics reckons that, during 1993 (when it conducted a trial survey on the new basis alongside the existing CPS), the unemployment rate derived from the new survey was, on average, about one-half of a percentage point higher than that derived from the old survey. However, recent movements in the unemployment rate suggest that the trial survey may have given a misleading impression of the actual

4. CBO's version of the CPI-U avoids the inconsistency (caused by a change in the treatment of home ownership in 1983) that distorts the official series.

5. See A.H. Young, "Alternative Measures of Change in Real Output and Prices: Quarterly Estimates for 1959-92," *Survey of Current Business* (March 1993), pp. 55-61; A.H. Young, "Alternative Measures of Change in Real Output and Prices," *Survey of Current Business* (April 1992), pp. 32-48; and J.E. Triplett, "Economic Theory and BEA's Alternative Quantity and Price Indexes," *Survey of Current Business* (April 1992), pp. 49-52.

impact of the change in survey method on the unemployment rate. Recent evidence indicates that the difference is smaller than previously thought--perhaps as small as one-tenth of one percentage point. CBO adjusts its estimate of the NAIRU by one-quarter of one percentage point (see Box 1-1 in Chapter 1 for more details).

Results of the Estimation

CBO's Phillips curve estimates yield good results--the equations fit the data well and satisfy a range of standard diagnostic criteria (see Table B-1). One aspect of the estimates deserves specific mention. In order to solve such equations for the NAIRU, the coefficients on lagged values of inflation must add up to one. In CBO's equations, the sum of the inflation coefficients is constrained to equal one. This constraint was tested statistically and was found to be justified in each equation at conventional levels of significance.

More important, the estimates of the NAIRU calculated from the different equations are all close to one another. CBO's preferred equation (using the benchmark-years-weighted price index for GDP) yields an estimate of the NAIRU for married males of 3.55, which implies an overall NAIRU of about 5.8 percent in 1993. Once it has been adjusted for the new CPS, the estimate of the NAIRU is 6 percent in early 1994. The estimates computed from the equations that use alternative measures of inflation are all within two-tenths of a percentage point of the first estimate. The estimate of the married-male NAIRU from the equation using the benchmark-years-weighted PCE price index is 3.63, that from the CPI-U equation is 3.72, that from the fixed-weighted PCE price index is 3.69, and that from the fixed-weighted price index for PCE less food and energy is 3.64.

Table B-1.
Estimated Coefficients from Phillips Curve Regressions to Determine the NAIRU

Independent Variables	Dependent Variable: Inflation				
	Benchmark-Years-Weighted Price Index (GDP)	Benchmark-Years-Weighted Price Index (PCE)	CPI-U	Fixed-Weighted Price Index (PCE)	Fixed-Weighted Price Index (PCE less food and energy)
Constant	2.45	2.50	2.87	2.67	1.92
	(5.2)	(4.4)	(5.0)	(5.5)	(5.3)
Lagged Inflation[a]	1.0[b]	1.0[c]	1.0[b]	1.0[b]	1.0[d]
Lagged Unemployment Rate (Married males)[e]	-0.69	-0.69	-0.77	-0.72	-0.53
	(5.4)	(4.5)	(4.9)	(5.5)	(5.4)
Food and Energy Prices[f]	0.19	0.43	0.43	0.34	n.a.
	(1.7)	(2.7)	(2.6)	(2.7)	
Productivity Deviation[g]	-0.10	-0.13	-0.06	-0.13	-0.10
	(2.9)	(2.8)	(1.3)	(3.4)	(3.0)
Wage and Price Controls					
On[h]	-0.75	-1.19	-1.83	-1.25	-1.37
	(1.3)	(1.5)	(2.2)	(1.8)	(2.3)
Off[i]	3.19	1.17	0.99	1.62	2.34
	(6.6)	(1.7)	(1.4)	(2.7)	(4.3)
R-Bar Squared	0.82	0.75	0.76	0.80	0.83
Number of Observations	117	119	152	152	152

SOURCE: Congressional Budget Office.

NOTES: T statistics appear in parentheses below coefficients.

NAIRU = nonaccelerating inflation rate of unemployment; GDP = gross domestic product; PCE = personal consumption expenditures; CPI-U = consumer price index for all urban consumers; n.a. = not applicable.

a. In each equation, lagged values of inflation are assumed to follow a third-degree polynomial distributed lag, with the far end point restricted to zero.

b. Lag length is 20 quarters.

c. Lag length is 18 quarters.

d. Lag length is 12 quarters.

e. Four lagged values of the unemployment rate for married males.

f. One period lag of food and energy prices; defined as the difference between the rates of growth of the fixed-weighted price index for PCE and the fixed-weighted price index for PCE less food and energy.

g. The difference between the rates of growth of labor productivity in the nonfarm business sector and trend labor productivity. The trend variable is segmented trend; its rate of growth is constant between business cycle peaks but differs between business cycles.

h. A dummy variable designed to control for the imposition of wage and price controls in 1971. (It equals 0.8 for the five quarters between 1971:3 and 1972:3.)

i. A dummy variable designed to control for the termination of wage and price controls in 1974. (It equals 0.4 in 1974:2 and 1975:1 and 1.6 in 1974:3 and 1974:4.)

Appendix C

Major Contributors to the Revenue and Spending Projections

The following analysts prepared the revenue and spending projections in this report:

Revenue Projections

Mark Booth	Corporate income taxes, Federal Reserve System earnings, excise taxes
Drew McMorrow	Excise taxes
Peter Ricoy	Social insurance contributions, estate and gift taxes
Melissa Sampson	Customs duties, miscellaneous receipts
David Weiner	Individual income taxes

Spending Projections

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Kent Christensen	Defense
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Raymond Hall	Defense
William Myers	Defense
Mary Helen Petrus	Veterans' compensation and pensions
Amy Plapp	Defense
Kathleen Shepherd	Veterans' benefits
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Peter Fontaine	Energy, Outer Continental Shelf receipts
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Theresa Gullo	Water resources, conservation, land management
James Hearn	General government, deposit insurance
David Hull	Agriculture
Mary Maginniss	Deposit insurance, Postal Service
Eileen Manfredi	Agriculture
Ian McCormick	Agriculture
Susanne Mehlman	Justice, Federal Housing Administration
David Moore	Spectrum auction receipts
John Patterson	Transportation
Deborah Reis	Recreation, water transportation
Rachel Robertson	Community and regional development, natural resources
Judith Ruud	Deposit insurance
Brent Shipp	Housing and mortgage credit
John Webb	Commerce, disaster relief

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Edward Blau	Appropriation bills
Jodi Capps	Appropriation bills
Karin Carr	Budget projections, other interest
Betty Embrey	Appropriation bills
Kenneth Farris	Computer support
Glen Goodnow	Authorization bills
Leslie Griffin	Budget projections, civilian agency pay
Bryan Grote	Credit programs
Vernon Hammett	Computer support
Sandra Hoffman	Computer support

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Deborah Keefe	Computer support
Fritz Maier	Computer support
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Robert Sempsey	Appropriation bills

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ISBN 0-16-045157-4